UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/995,421	11/27/2001	Won-Young Chung	5649-909	1882

20792 7590 05/14/2008
MYERS BIGEL SIBLEY & SAJOVEC
PO BOX 37428
RALEIGH, NC 27627

EXAMINER	
GEBRESILASSIE, KIBROM K	
ART UNIT	PAPER NUMBER
2128	
MAIL DATE	DELIVERY MODE
05/14/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	09/995,421	CHUNG ET AL.	
	Examiner	Art Unit	
	KIBROM K. GEBRESILASSIE	2128	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 February 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-10,12-19,21-28,30-32,34 and 35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-10,12-19,21-28,30-32,34 and 35* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 02/22/2008 has been entered.

2. Claims 1, 3-10, 12-19, 21-28, 30-32, 34, and 35 are presented for examination.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

4. Claims 1, 3, 5-10, 12, 14-19, 21, 23-28, 30-32, and 34-35 are rejected under 35 U.S.C. 102(a) as being anticipated by W. Y. Chung, J. J. Oh, T. K. Kim, J. K. Shin, K. Seo, Y. K. Park, and J. T. Kong, "Integrated Simulation of Equipment and Topography for Plasma Etching in the DRM Reactor," 2000 IEEE.

As per Claim 1:

Chung et al discloses a method of estimating characteristics of a plasma contained in a reaction chamber of a plasma reactor including a plurality of magnets that move with respect to the reaction chamber (See: Abstract), the method comprising:

obtaining configuration and process condition data for the reaction chamber (such as *process condition (Pressure, Power, Gas composition) Geometry of Fig. 1*), the data comprising a 3-dimensional distribution of a static electromagnetic field induced by the plurality of magnets in the reaction chamber (such as *...magnetic fields induced ....are 3-dimensionally computed using a commercial software...*; See: page 127, right side column, lines 19-23);

computing plasma characteristics for each of a plurality of cross-sections of the reaction chamber from the data (See: page 128, left side column, paragraph one and two), the plurality of cross-sections being selected from the 3-dimensionl distribution of the static electromagnetic field (such as *...the plasma parameters are computed at several 2-dimensional cross-sections with a distinctive magnetic field distribution...*; See: page 128, left side column, lines 1-3); and

generating a generalize model of the plasma from the computed plasma characteristics for the plurality of cross-sections (such as*...overall etching characteristics...*; See: page 128, left side column, paragraph one and two; Fig. 1 last step),

Chung et al discloses a plurality of rotating magnets (such as *...DRM reactor has...magnet structure around the reaction chamber, which rotates in tens of rpm to improve the uniformity.... (See: page 127 "Introduction" second paragraph)...VectorFields to accurately take account the magnetic fields arising from the rotating magnets (See: page 127 right side column, lines 2-8).*

However, Chung et al fails expressly to disclose an axis of rotation, and wherein each of the plurality of cross-sections includes the axis of rotation. However, the recited limitation is inherent to the following portion of Chung et al teachings:

For example,

> model, and the feature scale profile model [3]. The plasma equipment model is based on the HPEM [4] and the magnetic field is solved using FEM(Finite Element Method) based VectorFields to accurately take account the magnetic fields arising from the rotating magnets. The unified RF plasma

If there is a rotation, there must be an axis of rotation. Without having an axis of rotation, it is difficult to rotate magnets.

Further,

> Fig.1 shows the schematic of the integrated simulation flow from the plasma equipment to topography. First, the magnetic fields induced by the complex permanent magnets of the DRM equipment are 3-dimensionally computed using a commercial software, VectorFields. The calculated static magnetic showed a good agreement with the measured values and distributions.

The above recited magnetic field distribution induced by rotating magnets which also includes an axis of rotation because, as indicated above, without having an axis of rotation, it is difficult to rotate and induce a magnetic field.

Then,

> The plasma parameters are computed at several 2-dimensional cross-sections with a distinctive magnetic field distribution and overall etching characteristics are obtained

The 2-dimensional cross-sections are portion of the magnetic field distribution, which are induced by rotating magnets about an axis of rotation. Therefore, it is inherent each cross sections includes an/the axis of rotation.

As per Claim 2:

Canceled.

As per Claim 3:

Chung et al discloses a method according to Claim 1, wherein computing plasma characteristics for each of a plurality of cross-sections in the reaction chamber comprises performing the following actions for each of the cross-sections:

computing electron density and temperature for the cross-section using an iterative Monte Carlo computational procedure (See: Page 128, left side column, lines 10-12); and

computing ion and neutral species transmission phenomena for the cross-section from a plasma dynamics simulation (such as …*Ion Angular Distribution, Ion Energy Distribution in Kinetic Simulation*; See: Fig. 1 Step 4).

As per Claim 5:

Chung et al discloses a method wherein computing plasma characteristics for each of a plurality of cross-sections in the reaction chamber comprises computing the plasma characteristics for each plurality of cross-sections from at least one of a plurality of determined static magnetic field direction, shape information for he reaction chamber, and plasma collision reaction data (See: Page 128, left side column, lines 1-3).

As per Claim 6:

Chung et al discloses generating a generalized model of the plasma from the computed plasma characteristics for the plurality of cross-sections comprises computing at least one of an electron density distribution, a temperature distribution, a distribution of ion species, a distribution of neutral species, and a flux incidence (such as…*Ion, Radical Fluxes, E-field Density, Ion Angular Distribution, Ion Energy Distribution*...; See: Fig. 1 and Fig. 4).

As per Claim 7:

Chung et al discloses generating a generalized model of the plasma from the computed plasma characteristics for the plurality of cross-sections comprises averaging the computed plasma characteristics for each of the plurality of cross-sections (such as…*and overall etching characteristics are obtained by averaging over these several 2-D calculations*…;See: page 128, left side column, line 3).

As per Claim 8:

Chung et al discloses estimating an etching rate for a wafer positioned in the chamber from the generalized model of the plasma (such as …*the uniformity of the etch rate and profile evolution are obtained in terms of plasma process conditions*….;See: Page 128, left side column, Second Paragraph).

As per Claim 9:

Chung et al discloses the plasma reactor comprises a dipole ring magnet (DRM) plasma reactor (such as *DRM Reactor;* See: Abstract).

As per claim10:

The same rationale applies as claim 1.

As per claim 11:

Canceled.

As per claims 12, and 14-19:

The same rationale applies as claims 1, 3, and 5-9.

As per claim 20:

Canceled.

As per Claims 21, 23-27:

The same rationale applies as claims 3, and 5-9.

As per Claim 28:

Chung et al discloses a method of simulating plasma in a plasma apparatus having a plasma reactor and a plurality of paramagnet magnets which are asymmetrically arranged and rotate around plasma reactor at predetermined speed, comprising the steps of:

(a) inputting shape and process conditions (such as...*profiles in terms of the equipment operating parameters such as the gas composition ratio and power*….;See: Abstract; Fig. 1, Step one) and inputting plasma collision reaction data (such as... "contact profile"; Abstract);

(b) 3-dimensionally computing static magnetic fields induced by the permanent magnets (such as...*the magnetic field induced by complex permanent magnets of the DRM equipment are 3-dimensionally computed using a commercial software,*

VectorFields…; See: Page 127, right side column, Under a title "The Simulation Flow and Etch Model"; Fig. 1 Step two);

(c) computing electron density and temperature and interpreting the transmission phenomenon of ion and neutral species using the data of the steps (a) and (b) until they are converged (such as...*good agreement of the calculated and measured values and distribution*…; See: Page 127, right side column, Under a title "The Simulation Flow and Etch Model");

(d) obtaining overall plasma characteristics using the converged values (such as...*and overall etching characteristics are obtained*…;See: Page 128, left side column, line 3); and wherein the step(c) comprises plasma simulation at 2-dimensional cross-sections for cross-sectional magnetic field distribution in a characteristics magnetic field direction (such as...*based on VectorFields to accurately take account the magnetic fields arising from the rotating magnets*….;See: page 127, right side column, lines 4-8).

Chung et al discloses a the 2-dimensional plasma simulation is performed for a plurality of 2-dimensional cross-sections (See: Page 128, left side column, first and second paragraph).

However, Chung et al fails expressly to disclose an axis. However, the recited limitation, an axis, is inherent to the following portion of Chung et al teachings:

For example,

> model, and the feature scale profile model [3]. The plasma equipment model is based on the HPEM [4] and the magnetic field is solved using FEM(Finite Element Method) based VectorFields to accurately take account the magnetic fields arising from the rotating magnets. The unified RF plasma

If there is a rotation, there must be an axis of rotation. Without having an axis of rotation, it is difficult to rotate magnets.

Further,

> Fig.1 shows the schematic of the integrated simulation flow from the plasma equipment to topography. First, the magnetic fields induced by the complex permanent magnets of the DRM equipment are 3-dimensionally computed using a commercial software, VectorFields. The calculated static magnetic showed a good agreement with the measured values and distributions.

The above recited magnetic field distribution induced by rotating magnets which includes an axis of rotation because as indicated above, without having an axis of rotation, it is difficult to rotate and induce a magnetic field.

Then,

> The plasma parameters are computed at several 2-dimensional cross-sections with a distinctive magnetic field distribution and overall etching characteristics are obtained

2-dimensional cross-sections are part of the magnetic field distribution, which are induced by rotating magnets about an axis of rotation. Therefore, if the magnetic field distribution induced by rotating magnets about an axis, it is therefore inherent each 2 dimensional cross sections to include an/the axis of rotation.

As per Claim 29

Canceled.

As per Claim 30:

Chung et al discloses 2-dimensional plasma simulation obtains convergence values for the respective cross-sections, and averages them to obtain plasma characteristics (such as...*and overall etching characteristics are obtained by averaging over these several 2-D calculations*...;See: page 128, left side column, line 3).

As per Claims 31 and 32:

The same rationale applies as claims 9, and 28.

As per Claim 33:

Canceled.

As per claims 34, and 35:

The same rationale applies as claims 9, and 30.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claims 4, 13, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over W. Y. Chung, J. J. Oh, T. K. Kim, J. K. Shin, K. Seo, Y. K. Park, and J. T. Kong, "Integrated Simulation of Equipment and Topography for Plasma Etching in the DRM Reactor," 2000 IEEE, as applied to claims 1, 3, 5-10, 12, 14-19, 21, 23-28, 30-32, and 34-35 above, and further in view of P.L.G. Ventzek, R. J. Hoekstra, and M. J. Kushner, "Two-dimensional modeling of high plasma density inductively coupled sources for materials processing," 1994 American Vacuum Society.

As per Claim 4:

Although, Chung et al discloses the ion and neutral species transmission phenomena for the cross-section from a plasma dynamics simulation such as obtaining ion angular distribution, ion energy distribution in kinetic simulation using a Monte Carlo simulation (See: Fig. 1 Step 4).

Chung et al fails expressly to disclose computing solutions to a continuity equation and Poisson's equation for the ion and neutral species.

Ventzek discloses computing solutions to a continuity equation and Poisson's equation for the ion and neutral species such as solving the continuity equations and Poisson's equation for all charges and neutral species in Fluid Chemical Kinetic Simulation (See: Page 464, Right side column, lines 9-11 and Equation 12 and Equation 13).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teachings of Ventzek et al with Chung et al because both references are clearly concerned with etching process of semiconductor materials. The motivation for doing so would have been more convenient to solve the Poisson's equation for a future time using a prediction for the charge densities based on the present values of their time derivatives to overcome the limitation imposed by dielectric relaxation time (See: Page 465, left side column, lines 27-31).

As per Claims 13 and 22:

The same rationale applies as claim 4.

Response to Arguments

7. Applicants are thanked for amendments/remarks.

8. Applicant's arguments with respect to claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

9. All Claims are rejected.

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

For example,

A Two-Dimensional Etching Profile Simulator: ESPRIT

SHUICHI YAMAMOTO, TOKUO KURE, MASANORI OHGO, TOSHIHARU MATSUZAMA, SHIN'ICHI TACHI, AND HIDEO SUNAMI

teaches:

> *Abstract*—A two-dimensional etching simulator named ESPRIT[1] has been developed to simulate LSI patterning. The etching simulator includes isotropic and anisotropic components. Its calculation method is based on the string model. ESPRIT can simulate etched profiles for multilayers with different etching rates and calculate side etching using sloped incidental anisotropic components. In addition, location correction, loop elimination, point insertion, and point elimination are provided for stable and accurate calculations. Simulated profiles coincide well with those from experiments in terms of relationship between the groove width and etched depth. ESPRIT can support to design LSI patterning process.

Examiner Remarks

11. Examiner's Note: **Examiner has cited particular columns and line numbers in the references applied to the claims above for the convenience of the applicant.** Although the specified citations are representative of the teachings of the art and are applied to specific limitations within the individual claim, other passages and figures may apply as well. **It is respectfully requested from the applicant in preparing responses, to fully consider the references in their entirety as potentially teaching all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.**

Examiner Request

12. **In the case of amending the claimed invention, Applicant is respectfully requested to indicate the portion(s) of the specification which dictate(s) the structure relied on** for proper interpretation and also to verify and ascertain the metes and bounds of the claimed invention.

MPEP states:

> "...with respect to newly added or amended claims, applicant should show support in the original disclosure for the new or amended claims. See MPEP § 714.02 and § 2163.06."

Communications

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kibrom K. Gebresilassie whose telephone number is 571-272-8571. The examiner can normally be reached on 8:00 am - 4:30 pm Monday to Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamini Shah can be reached on 571-272-2279. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/K. K. G./
Examiner, Art Unit 2128

/Hugh Jones/

Primary Examiner, Art Unit 2128